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**Aristotle** (384-322)

Classified and organized existing knowledge of physical world

- Natural Motion
  - up, down, circular
- Violent Motion (imposed motion)
  - push, pull
  - externally caused
  - imparted to objects
- All motions are due to the nature of the moving object or due to a sustained push or pull.
- If an object is in its proper place, it will not move unless subjected to a force.
- Normal state of objects = rest  
*(except for celestial bodies)*

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**Copernicus** (1473-1543)

It was thought, until the 16th century:  
Earth is in its proper place  
No force capable of moving the Earth  
Earth does not move

- Copernicus:  
simplest way to account for the observed motions of the sun, moon, and planets through the sky was to assume that the Earth circles the sun.
- *De Revolutionibus*
- the idea of a moving Earth threatened
  - authority
  - foundations of faith
  - Civilization
- *Revolutionary idea*
  - overturned conception of the cosmos
  - Eventually embraced by the Church

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### Galileo (1564-1642)

Supported Copernican view of a moving Earth.

Discredited Aristotle's ideas about motion

Observation and experiment



[Link to Galileo's experiments](#)

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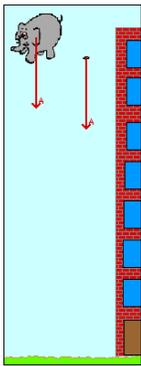
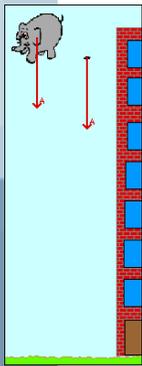
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### Falling Objects

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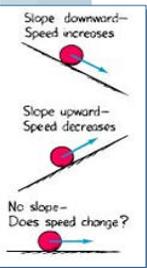
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### Galileo's inclined planes

- Balls rolling on downward-sloping planes pick up speed.
- Balls rolling on upward-sloping planes lose speed.
- Therefore balls rolling along a horizontal plane neither speed up nor slow down.
- Balls would finally come to rest not because of friction, not *nature*
- Support
  - with less friction, the motion of objects persists for a longer time
  - the less the friction, the more the motion approached constant speed.
- In the absence of friction (or other opposing forces), a horizontally moving object continues moving indefinitely.

[Link to Galileo's experiments](#)

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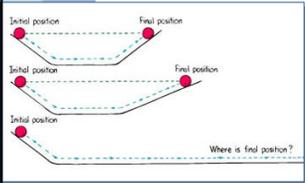
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### Inclined planes facing each other



- Ball released from a rest at top slope plane rolls down and then up until it almost reaches its initial height.
- If angle of the up-slope is reduced, the ball rises to the same height, but goes farther.
- Therefore, on a long horizontal plane, ball goes on forever ..... it never reaches initial height

[Link to Galileo's experiments](#)

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### Isaac Newton (1642-1721)

Universe runs according to natural laws

- Aristotle: a moving object is propelled by a steady force
- Galileo: in the *absence* of a force, a moving object will continue moving.  
*inertia*: the tendency of things to resist changes in motion
- Newton: refined Galileo's idea  
*Law of Inertia*

*An object at rest tends to stay at rest and an object in motion tends to stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force.*

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### Inertia




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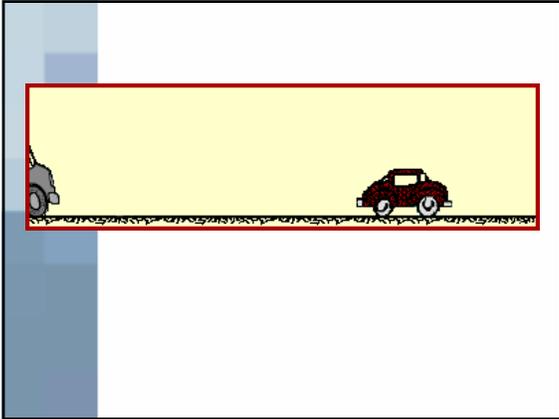
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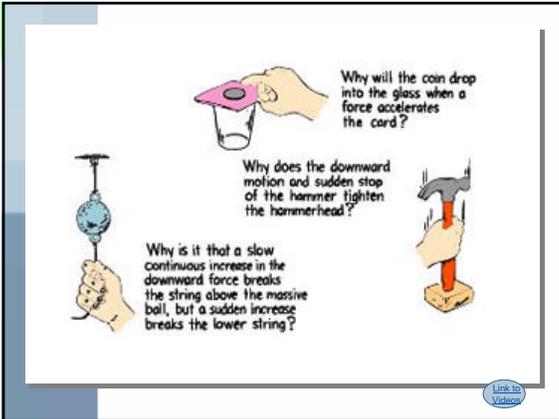
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### Forces

Applied forces	Net force

push or a pull

*Net force.*

- pull in the same direction with equal forces on an object
  - net force = 2 x single force
- pull with equal forces in opposite directions
  - net force = 0

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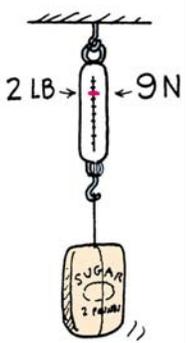
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### Equilibrium Rule

*For any object or system of objects in equilibrium the sum of the forces acting equals zero*



$$\sum F = 0$$

↑ Tension force acts upwards  
 ↓ Weight acts downwards

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### Types of Forces

Contact Forces	Action-at-a-Distance Forces
Frictional Force	Gravitational Force
Tensional Force	Electrical Force
Normal Force*	Magnetic Force
Air Resistance Force	
Applied Force	
Spring Force	

\*Normal Force = Support Force = upward force opposite to force of gravity

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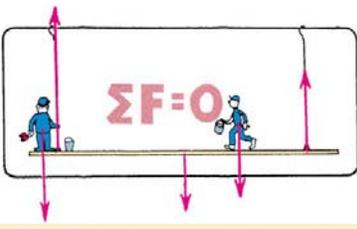
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### Object at rest....sum of forces = 0



$\sum F = 0$

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